

**Commonwealth of the Northern Mariana Islands
Passive Acoustic Monitoring Site SAI1
Saipan Island, Northeast Side**

**Ecological Acoustic Recorder (EAR)
19-May-2007 to 18-Apr-2009**

Level 1 Analysis of Passive Acoustic Observations¹

(Revised 22 July 2009)

Synopsis

This document provides a level 1 analysis of the data obtained from ecological acoustic recorder (EAR) unit 9300312B028 deployed on the northeast side of Saipan from May 2007 to April 2009. The EAR unit recorded acoustic data from June 1st 2007 to February 23rd 2008. This initial report contains background information about the site, time-series of total acoustic energy, and analyses of event-triggered recordings.

Background

Monitoring the changing status of coral reef environments and associated biota is a critical management need and a considerable technological challenge, especially on reefs in remote locations. The Pacific Islands Fisheries Science Center (PIFSC) Coral Reef Ecosystem Division (CRED), in partnership with the Hawaii Institute of Marine Biology (HIMB), is using natural ambient sounds as a way to characterize the activity of marine organisms on coral reefs and in surrounding waters. By deploying a device known as the Ecological Acoustic Recorder (EAR), a cost-effective tool for recording biological and anthropogenic sounds, CRED investigates and monitors the presence and activity of sound-producing marine life and human activity. The EAR can be left in place unattended for up to two years, depending on the instrument's configuration. Passive acoustic observations are typically not compromised by bio-fouling. It records the local ambient acoustic environment on a programmed schedule and is also triggered to record by high amplitude transient events, such as engine noise from passing vessels.

This level 1 report is the product of an initial analysis of the EAR dataset from EAR unit 9300312B028 deployed on the northeast side of Saipan Island in the Commonwealth of the Northern Mariana Islands (CNMI) from May 19th 2007 to April 18th 2008. The unit recorded data from June 1st 2007 to February 23rd 2008. This report includes a time series of total acoustic energy, an analysis of the event-triggered recordings, and a discussion of results. A subsequent level 2 report will include an analysis of additional concomitant variables collected in conjunction with the EAR that may include tidal phases, episodic storms, wave events, temperature, primary productivity, etc. The level 2 report will also include an analysis of cetacean vocalizations. A level 3 report will describe unique fish sounds that have been isolated during bioacoustic analysis. The level 3 report will also discuss the temporal variability in

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occurrence of these sounds and present summary tables and graphic products. A final level 4 report will be an integrative study comparing data from multiple years and multiple EAR monitoring sites at island or archipelagic scales. It is anticipated that level 4 reports will take the form of manuscripts for publication in peer-reviewed scientific journals.

Deployment Site

EAR unit 9300312B028 was deployed on the northeast side of Saipan from May 19th 2007 to April 18th 2009 (Figures 1 and 2) with attached subsurface temperature recorder 3936859-1653. The deployment site (SAI1) is near the CRED Rapid Ecological Assessment (REA) site 1. Immediately after recovery of EAR unit 9300312B028, replacement unit 9300495B103 was deployed in the same location to continue the passive acoustic monitoring of this site.

Two passive acoustic monitoring sites (SAI1, SAI2) are currently maintained on the east side of the island of Saipan (Figure 2). Other EAR sites in this region include the near-shore waters of Guam, Rota, Pagan, and Maug islands. (Figure 3).



The site SAI1 is north of Bird Island and within the Bird Island Sanctuary, which is a marine protected area. Besides the five marine protected areas around Saipan, there are three no-take marine conservation areas and two species-based reserves (Schroeder, 2007). Gill-netting is prohibited except for traditional events, and scuba spearfishing is banned in the CNMI.

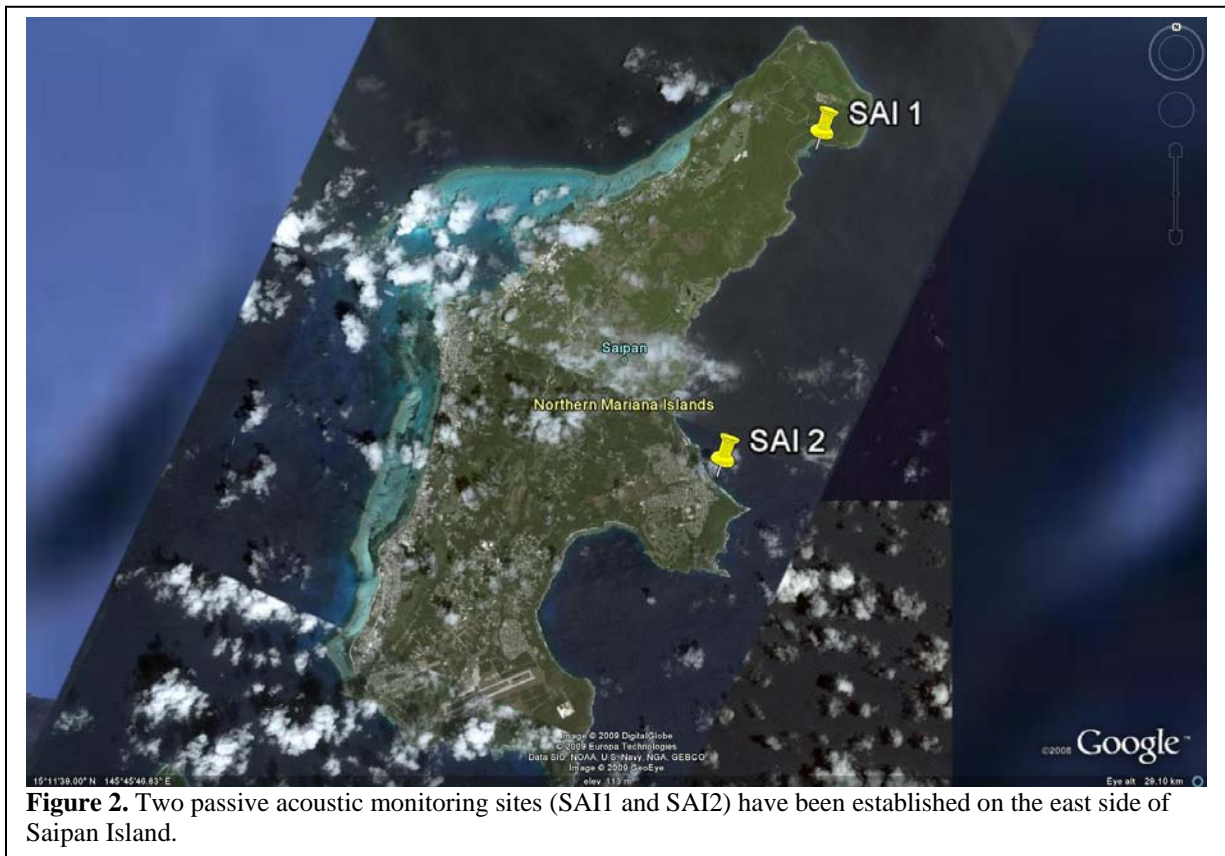


Figure 2. Two passive acoustic monitoring sites (SAI1 and SAI2) have been established on the east side of Saipan Island.

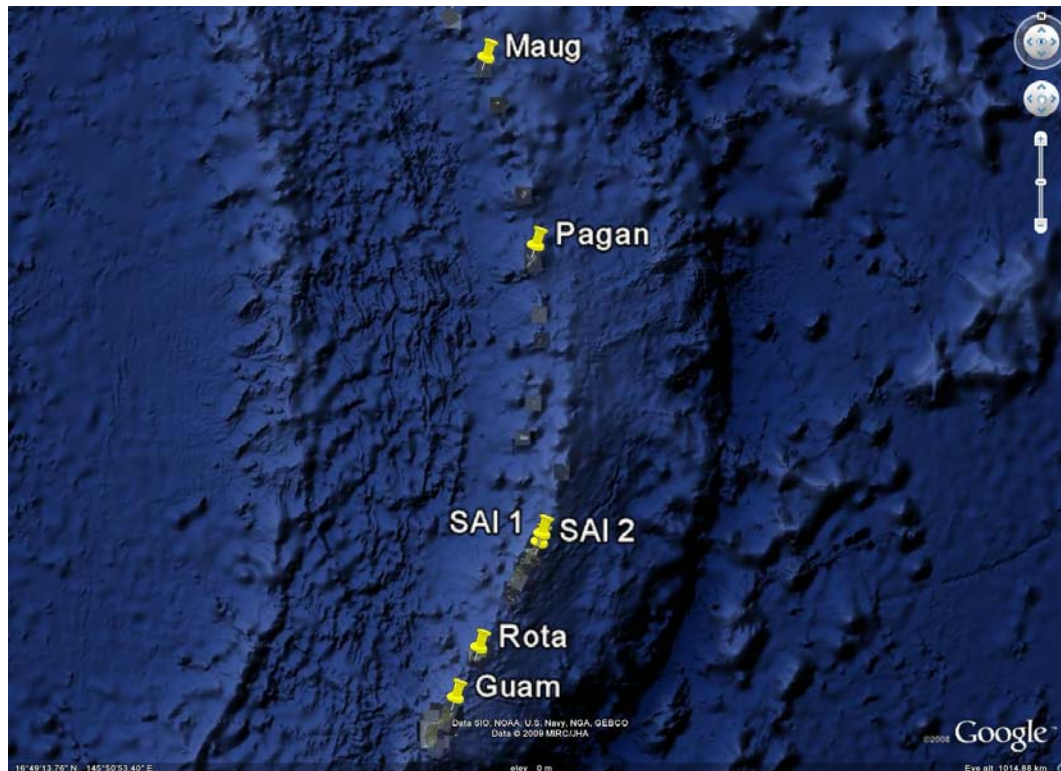


Figure 3. As of 2009, Ecological Acoustic Recorder (EAR) sites in this region include the islands of Guam, Rota, Saipan, Pagan, and Maug.

Total acoustic energy

A time series of total acoustic energy provides a synoptic view of the major trends and variability of the acoustic activity at this site, as seen in Figure 4.

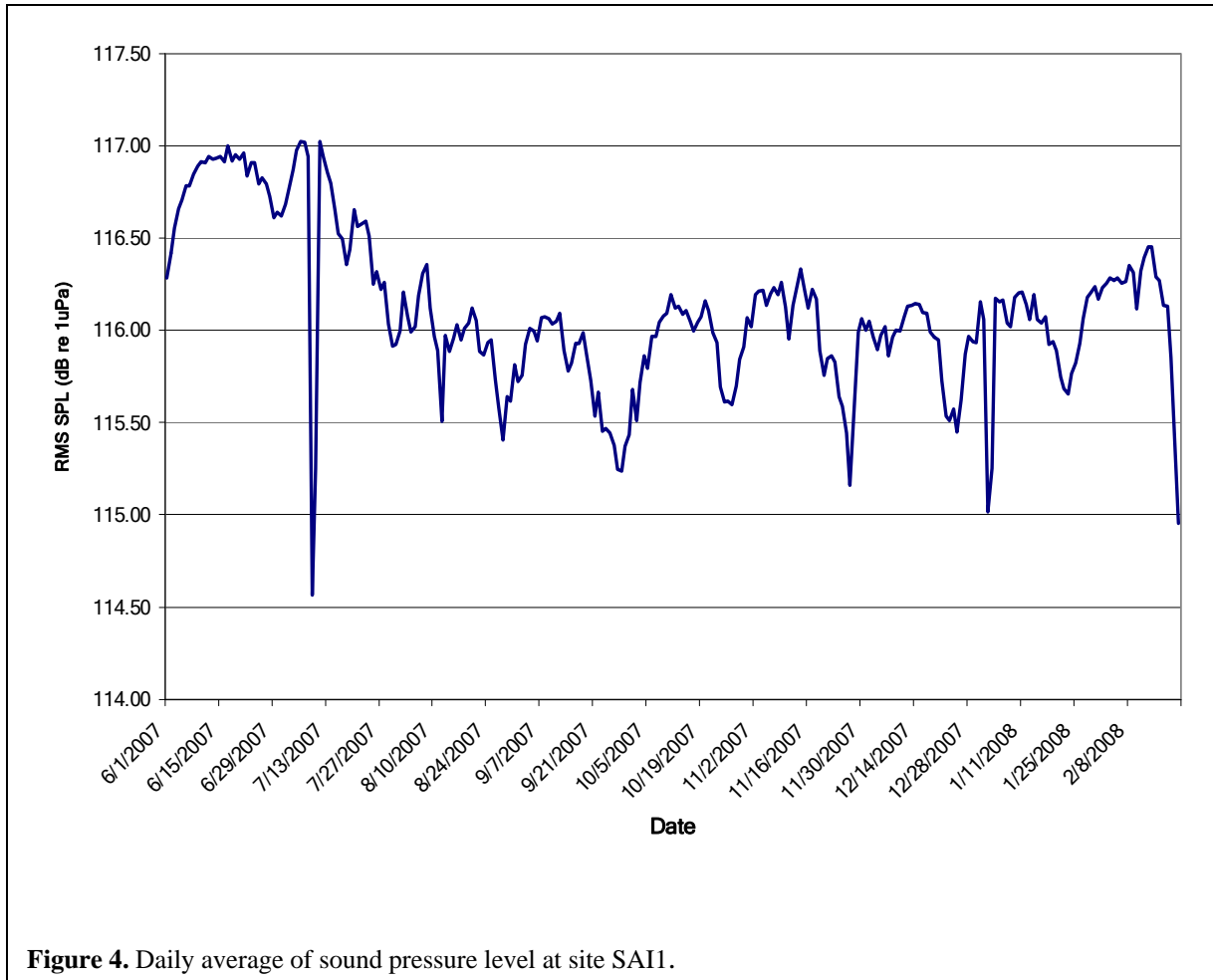


Figure 4. Daily average of sound pressure level at site SAI1.

The acoustic energy record, as obtained from the periodic duty-cycle recordings made by the EAR, shows strong diel variability (Figure 5). Nighttime Root Mean Square (RMS) Sound Pressure Levels (SPL) are 2-3 dB higher than during the day, where nighttime is defined as the four hour period from midnight to 4 AM (local time) and daytime is defined as the four hour period from noon to 4 PM (Figure 6). In addition, there is evidence of periodic variability on the scale of several weeks. A general trend of decreasing ambient acoustic levels over the course of the deployment from June to September is evident, suggesting some degree of seasonal variability. The major source of observed ambient acoustic energy was from snapping shrimps, so the diel and periodic variability are attributed to changes in their activity levels. Other major contributing sound sources include vessel engines, sonar, rain or storm conditions, and fish. Sporadic spikes in ambient acoustic energy levels represent episodic events involving one or more of these sound sources.

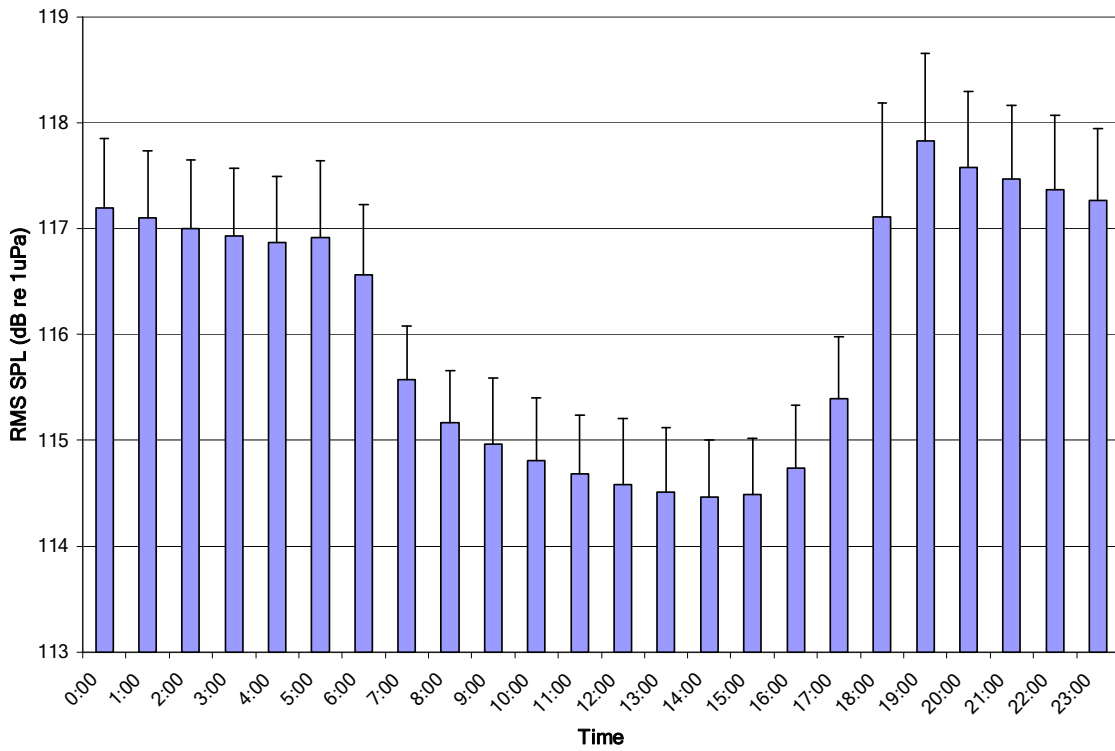


Figure 5. Average Sound Pressure Level (dB) by hour of day (local time).

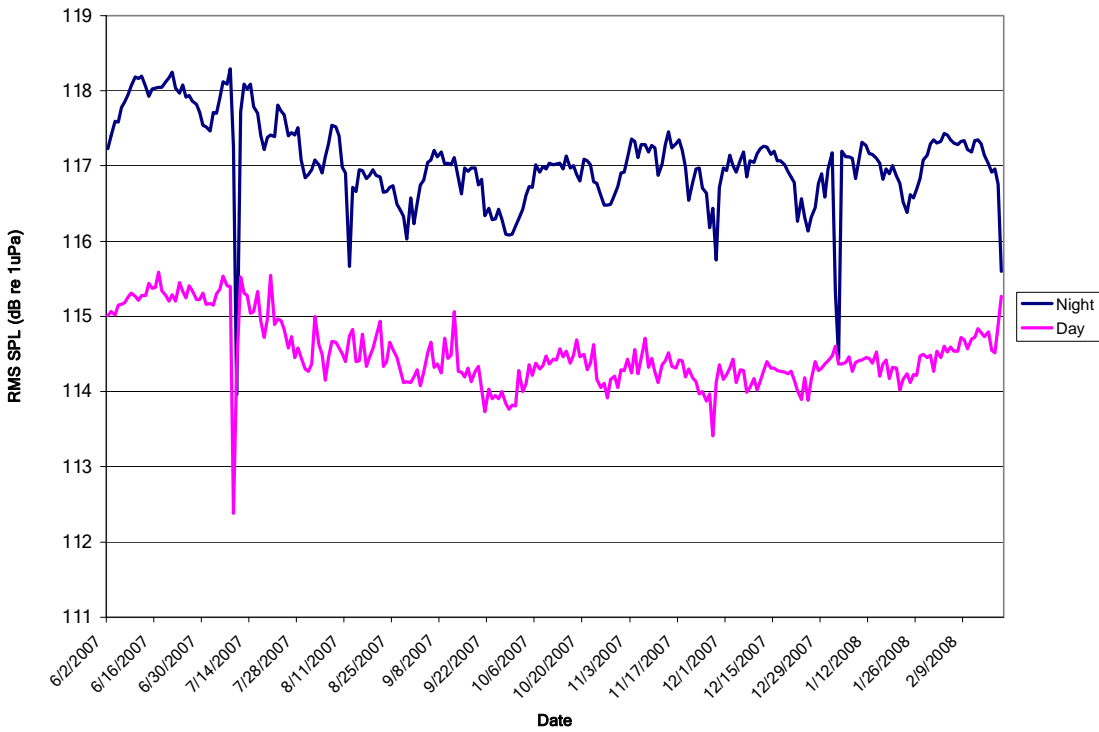


Figure 6. Average night and day Sound Pressure Level (dB) at passive acoustic monitoring site SAI1, Saipan, CNMI.

There is a downward spike in the daily average sound pressure level on July 9th, 2007. A plot of sound pressure levels from July 8th through July 12th shows a low value of 107.7 dB (Figure 7). Other data sets have shown storm conditions or rain events to be correlated with significant drops in SPL (PIFSC, 2009). A rain event on July 9th at 5:00 local time was significant enough to be detected in the acoustic dataset. However, the downward spike occurred at 19:00 local time. Due to the significant time lapse of 14 hours, it is not certain that this event was what triggered the drop in SPL. It is possible that there was a rain or storm event closer to the time of the SPL drop that was not detected or that other factors, such as surface-breaking waves or strong currents, may have had an influence.

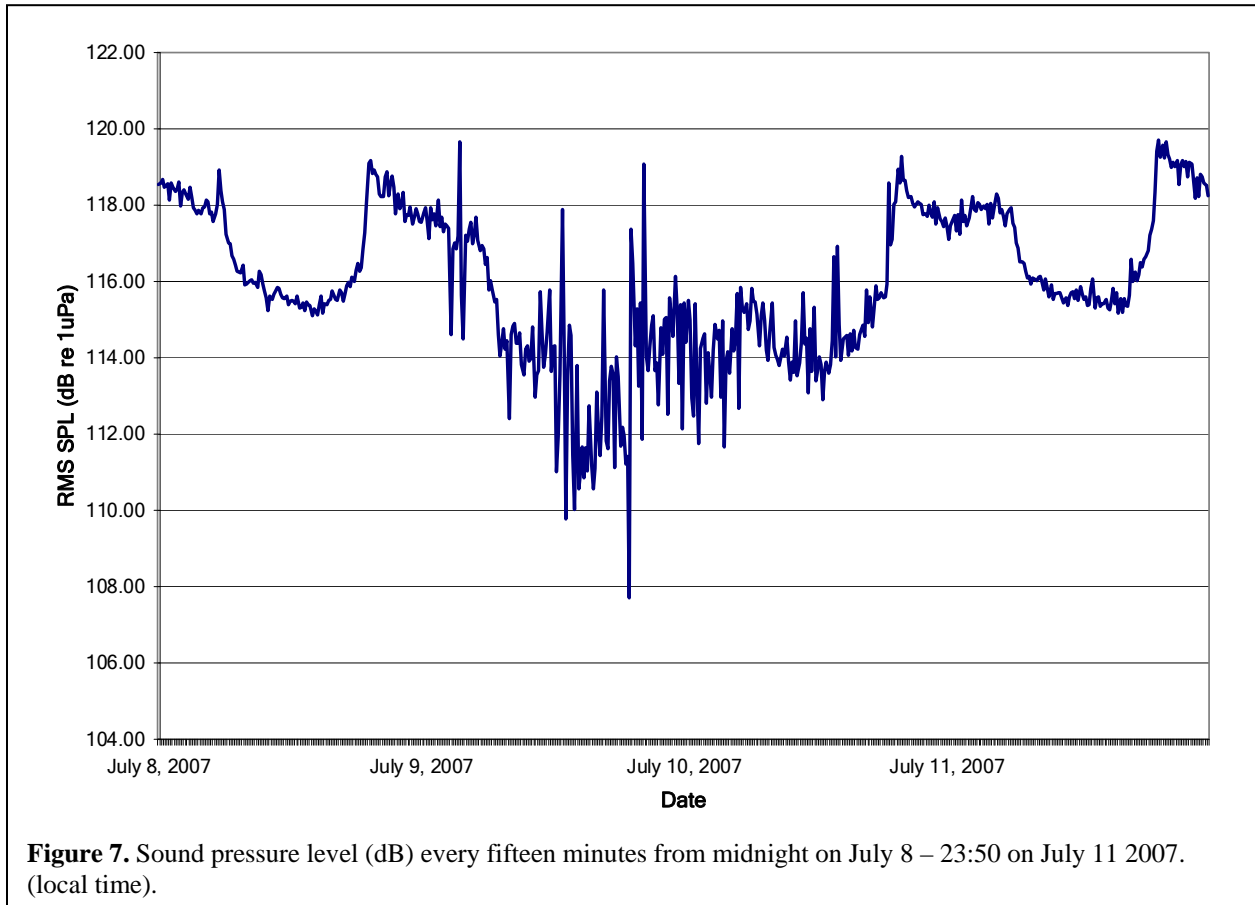
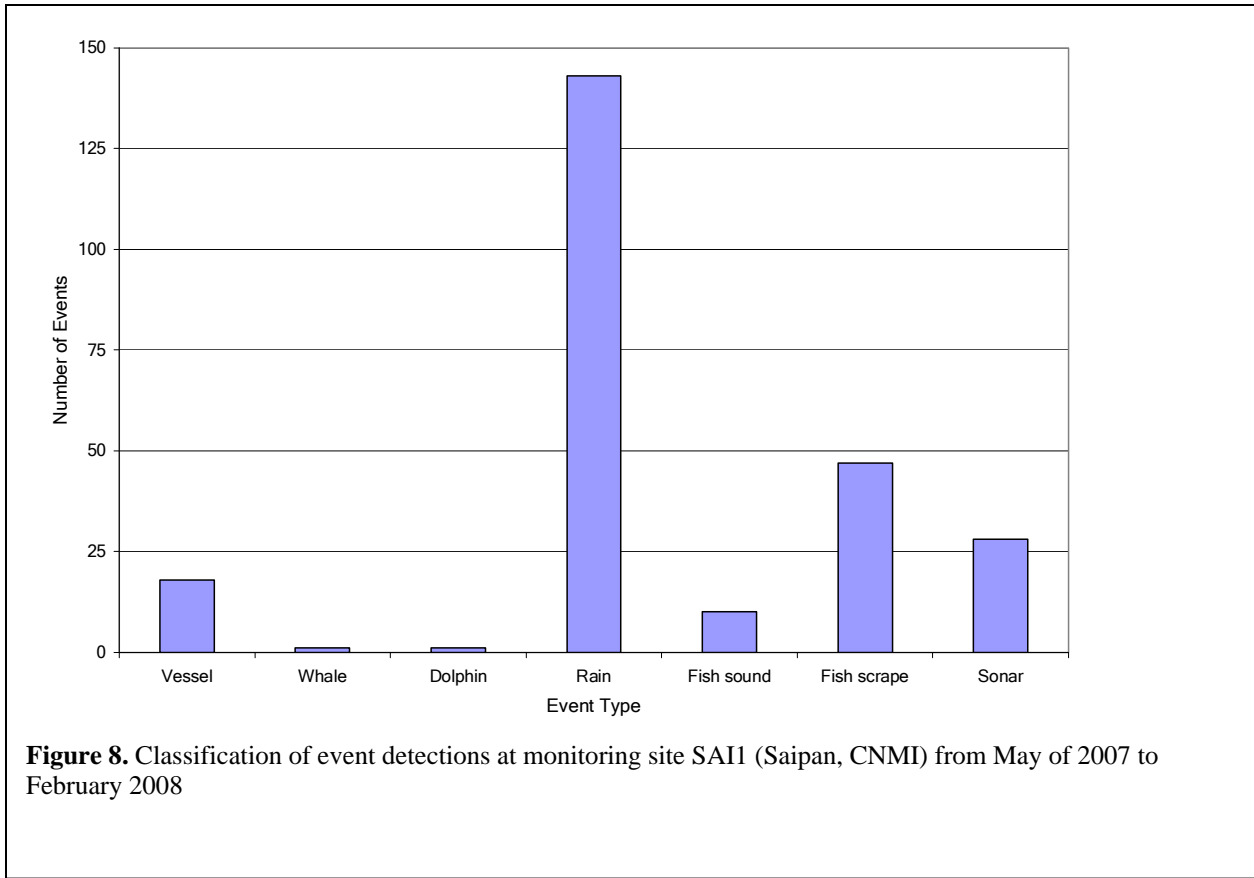


Figure 7. Sound pressure level (dB) every fifteen minutes from midnight on July 8 – 23:50 on July 11 2007. (local time).

Analysis of event-triggered recordings

An analysis of all the event-triggered recordings provides insight into the patterns of activity for motorized vessels, cetaceans, and other acoustic sources in the vicinity of the EAR. Figure 8 shows the classification of event-triggered recordings at the site.



Each vessel event recording was linked to the date/time of the recording to generate a plot of vessel occurrences in the vicinity of the monitoring site by time of day (Figure 9) and by month of year (Figure 10). Similar analyses, not included in this report, can be performed on the other types of events (cetaceans, fish sounds, etc.) The complete record of event triggered vessel detections is included as Table 1.

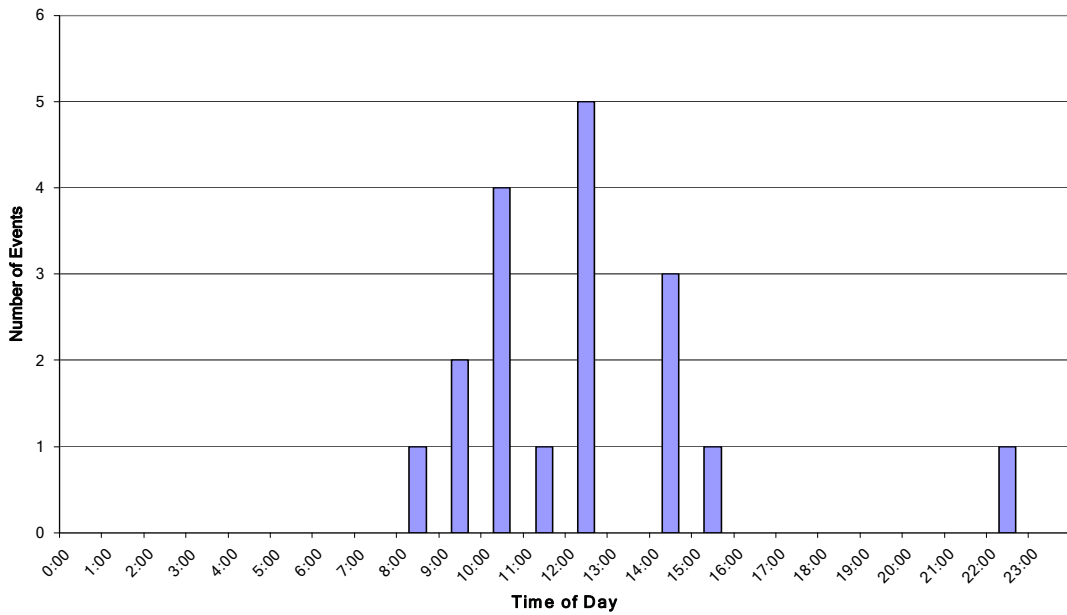


Figure 9. Vessel event classified by time of day (local time). Note: several events occurred on the same date a few minutes apart and are probably the same vessel.

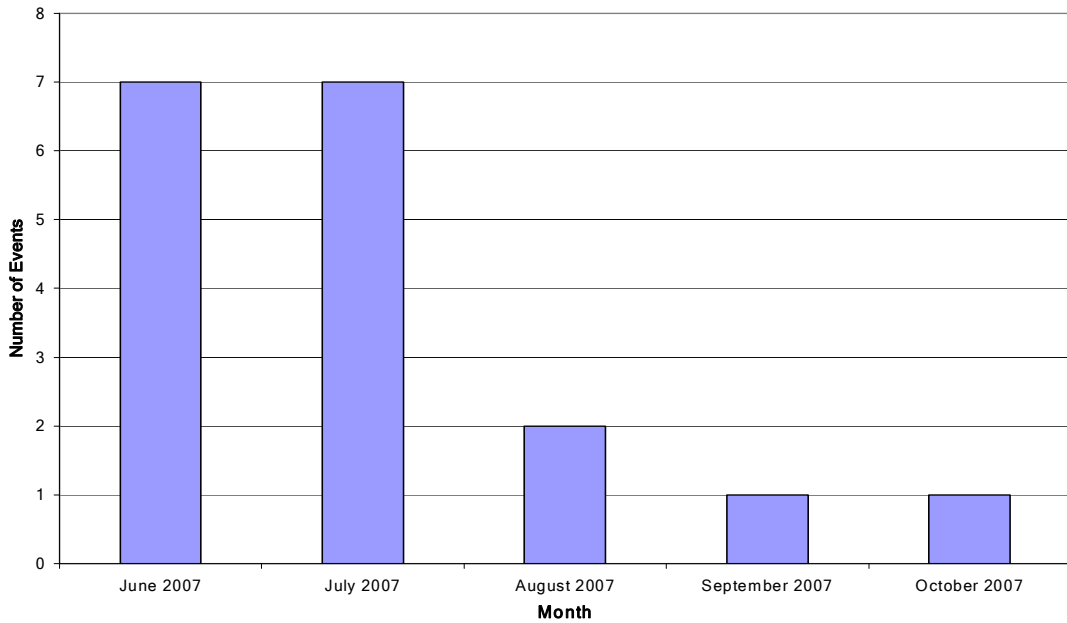
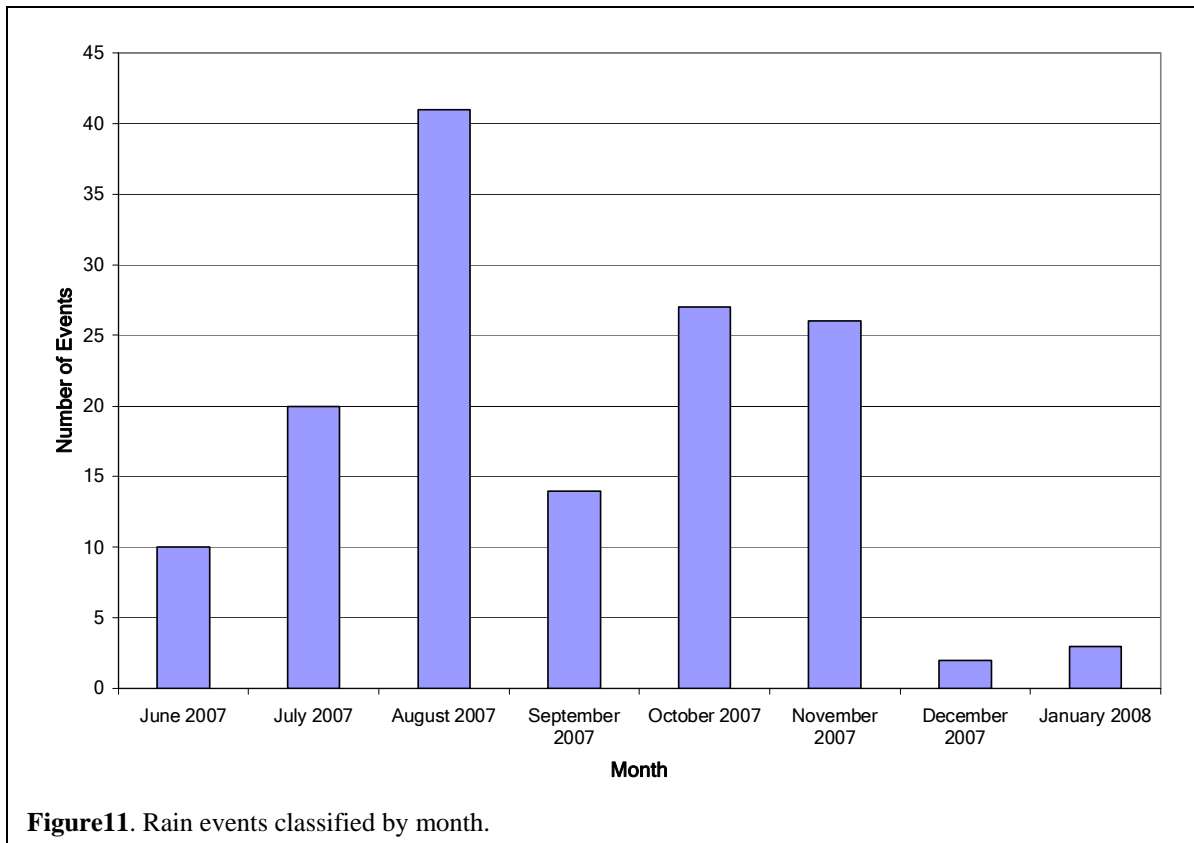


Figure 10. Vessel events classified per month. Note: several events occurred on the same date a few minutes apart and are probably the same vessel.

Table 1. UTC and local date and time of vessel events at SAI1 (Saipan, CNMI) from June 2007 to February 2008.

Vessel Event		
Date/Time - UTC	Date/Time - Local	File
6/27/2007 02:54	6/27/2007 12:54	00003764.BIN
6/27/2007 23:41	6/28/2007 9:41	00003890.BIN
6/28/2007 00:19	6/28/2007 10:19	00003894.BIN
6/28/2007 01:34	6/28/2007 11:34	00003903.BIN
6/30/2007 02:07	6/30/2007 12:07	00004197.BIN
6/30/2007 02:08	6/30/2007 12:08	00004198.BIN
6/30/2007 02:41	6/30/2007 12:41	00004203.BIN
7/1/2007 05:53	7/1/2007 15:53	00004374.BIN
7/20/2007 00:30	7/20/2007 10:30	00007161.BIN
7/22/2007 04:12	7/22/2007 14:12	00007477.BIN
7/22/2007 22:58	7/23/2007 8:58	00007591.BIN
7/23/2007 04:01	7/23/2007 14:01	00007623.BIN
7/23/2007 04:10	7/23/2007 14:10	00007625.BIN
7/28/2007 23:59	7/29/2007 9:59	00008466.BIN
8/11/2007 00:28	8/11/2007 10:28	00010389.BIN
8/17/2007 00:37	8/17/2007 10:37	00011261.BIN
9/9/2007 02:30	9/9/2007 12:30	00014614.BIN
10/1/2007 12:49	10/1/2007 22:49	00017864.BIN

The dominant sounds that triggered this EAR unit were rain events, at 143 events over a span of 9 months. These events are classified by month (Figure 11).



Discussion:

The EAR unit was deployed on May 19th of 2007 and recovered on April 18th 2009. The unit recorded acoustic data from June 1st 2007 to February 23rd 2008.

During the twenty-three-month period of deployment of the EAR, a nine month dataset was recovered. During that period of time, vessel activity was recorded in the vicinity of the monitoring site from June 2007 through October 2007. Interestingly, no vessel activity was detected between November 2007 and February 2008. Continued monitoring of the site will provide a more comprehensive assessment.

The dominant sound that triggered event detection on EAR unit 9300312-28 was rain, with 143 recorded events. Figure 11 shows that rain events increased beginning in July, peaked in August, and subsided in December. This correlates with Saipan’s rainy season, which generally runs from July to November (Takano and Haig 2004).

The next most dominant sounds were fish scrapes with 47 events. These sounds presumably happen when fish fed on the bio-fouling organisms growing on or near the recorder.

Twenty-eight events had characteristics of sonar-like signals. These events most likely represent military sonar activity.

Note:

This report is distributed to NOAA offices and resource management agencies of the local jurisdiction. Due to the potentially sensitive nature of this data and to prevent vandalism or theft of the deployed instruments, discretion is advised when re-distributing the information contained in this report.

Contact Information:

The Ecological Acoustic Recorder (EAR) program is a collaborative effort of the Pacific Islands Fisheries Science Center and the Hawaii Institute of Marine Biology. For more information please visit the following URL or contact the following individuals.

<http://www.pifsc.noaa.gov/cred/ear.php>

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Pacific Islands Fisheries Science Center Cruise Report CR-07-011, 6 July 2007, 133 pp.
- Takano, L.L. and Haig, S.M. 2004. Seasonal Movement and Home Range of the Mariana Common Moorhen. *The Condor* 106 (3): 652-653.

Pacific Islands Fisheries Science Center, 2009, Northwestern Hawaiian Islands Passive Acoustic Monitoring Site KUR (Kure Atoll, NWHI) Ecological Acoustic Recorder (EAR) 19-September-2006 to 29-September 2008 Level 1 Analysis of Passive Acoustic Observations, Internal Report IR-09-017, Issued 5 May 2009.